Some Nutritional Means to Stimulate Feed Intake in Newly Weaned Piglets

October, 1998

C.F.M. de Lange[1] and S.K. Baidoo[2]

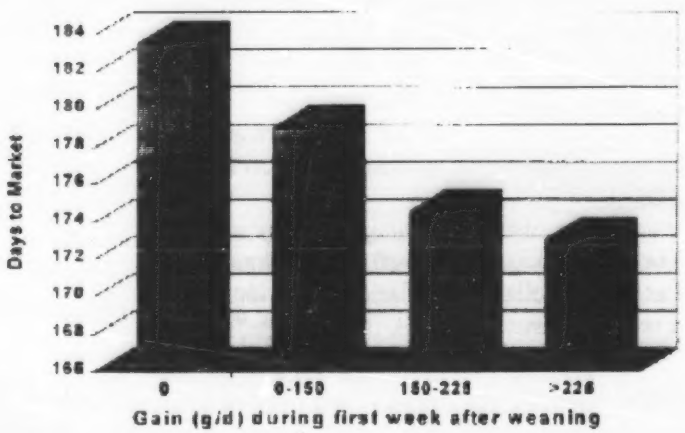
[1]Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario N I G 2W I;
[2] Department of Animal Science, University of Manitoba, Winnipeg, Manitoba R3T 2N2

(From Proceedings of 16 Annual Centralia Swine Research Update January 29, 1997, Kirkton-Woodham Community Centre)

INTRODUCTION

Under commercial conditions, young piglets rarely achieve their potential for (lean) growth. Already in 1974 the British researcher Hodge got piglets to gain 576 g/d between 10 and 30 days of age. In his experiment he fed reconstituted cows milk (20% dry matter) to the piglets. Yet, under practical conditions growth rates in piglets of this age are generally around 200-250 g/d. In addition, growth rates are usually lower than that during the period immediately following weaning. Growth rates around the time of weaning not only determine throughput in (expensive) nursery facilities; they also influence growth rates up to market weight. For example, researchers at Kansas State University demonstrated that piglets gaining more than 225 g/d during the first week after weaning required about 10 days fewer to reach market weight as compared to these piglets that did not gain any weight (Figure 1).

Figure 1. Relationship between growth rate during the first week after weaning and time to reach market weight in growing pigs (Tokach et al., 1992).



Sub-optimal growth during the post-weaning period is largely the result of the piglet's inability to consume and digest sufficient amounts of nutrients (energy, amino acids, etc.).

In this contribution some dietary and feeding factors that affect the feed utilization and feed intake by young piglets will be considered. It should be emphasized that

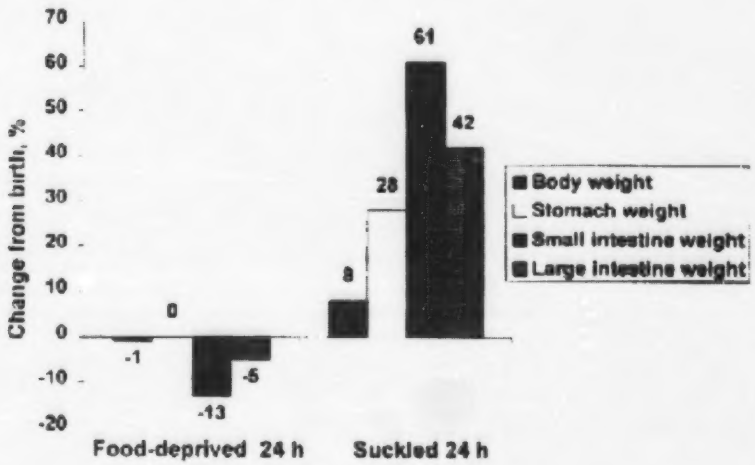
101-05340/

not all of the dietary factors that affect feed intake are reviewed in this contribution. Environmental factors that are known to have important effects on feed intake, such as health status, environmental temperature, stocking density, and feeder design and management, are not addressed either.

SOWS' MILK - MORE THAN A SOURCE OF DIETARY NUTRIENTS.

As indicated by the results presented in Figure 2, milk has a tremendous stimulating effect on the development of the digestive system of the young piglet. In piglets that consume sows' milk the size of the small intestine, the part of the gut where most of the nutrients are absorbed, increases by as much as 61 % in one day. In contrast, the size of the small intestine of starved piglets decreased by about 13%. From the data summarized in Table 1 it is obvious that sows' milk provides more than just nutrients and protection against disease; it also contains compounds that stimulate the digestive capacity in young piglets. It is thus not surprising that when we remove sows' milk from the diet, the piglets' ability to digest dietary nutrients is reduced. This, in turn, will result in reduced feed intake. For the development of post-weaning diets important lessons can thus be learned from the composition of sows' milk.

Figure 2. Effect of milk intake on the development of the digestive tract in newborn piglets (Widdowsen et al., 1976).



Nutrients in sows' milk

Sows' milk is an excellent source of highly digestible nutrients. On a dry matter basis it contains approximately 45% fat, 25% lactose (milk sugar; a carbohydrate), 28% protein; the remainder is made up of vitamins and minerals. Most weaner diets are much lower in fat (often less than 10%), higher in carbohydrate (and starch in particular) and quite similar in protein content as compared to sows' milk. These differences in nutrient profile between sows'milk and the weaner diet are likely to result in reductions in performance around the time of weaning.

Table 1. Composition of sows' milk.

Nutrients:
Energy (fatty acids, lactose, amino acids)
Protein (amino acids)
Vitamins and minerals
Protective factors:

Immunoglobulins (anti-bodies)
Protective cells (macrophages, lymphocytes)
Regulatory factors:
Epidermal growth factor (EGF)
Insulin
Insulin like growth factor (IGF)
Prostaglandins
Polyamines
Enzymes:
Lipase
Amylase

It is beyond this contribution to discuss the effects of the various nutrients and sources of nutrients on performance of newly weaned piglets. For more information on this topic the reader is referred elsewhere (Pettigrew et al., 1994; Swine Nutrition Guide, 1995; Pluske et al., 1995; Neissen et al., 1995). Only some recent findings will be discussed.

An important point to consider is the digestibility of the various ingredients that may be included in pig diets. For example, the data in Table 2 illustrate that there are important differences in the digestibility of protein in various feedstuffs.

Table 2. Faecal digestibility of protein in various feed stuffs and determined in piglets at various ages*.

	Age of Piglets		
Feedstuff	3.5 weeks	4.5 weeks	5.5 weeks
Soybean meal	71	75	87
Skim milk	93	95	95
Fish meal	86	89	91
Potato protein	93		95

*van der Kerk, 1982

As there is a close relationship between nutrient digestibility and feed intake, only highly digestible ingredients should be considered in weaner pig diets. Furthermore, the differences in digestibilities between feedstuffs are much larger in piglets of 3.5 weeks of age than in piglets at 5.5 weeks of age. As diets are usually formulated based on digestibility coefficients determined in older pigs, these age effects on digestibilities are ignored. At the same time, if we were able to improve the digestive capacity of the young piglet we will be able to use inexpensive ingredients with a relatively low digestibility, such as soybean meal, more effectively at an earlier age. An interesting ingredient that is increasingly used in starter pig diets in Western Europe is isolated potato protein. This source of protein has a very favourable amino acid balance and is free of anti-nutritional factors that can cause digestive upsets in young piglets.

Table 3. Effects of dietary lactose levels on performance during the first 14 days after weaning*

	Dietary lactose level				
	7%	11%	15%	19%	23%
Gain, kg/d	.20	.21	.25	.24	.26
Feed intake, kg/g	.25	.27	.27	.27	.29
Feed:Gain	1.27	1.30	1.14	1.16	1.11

*Owen et al., 1993; In total 387 piglets were used that were weaned at 21 days of age and at 5.4 kg body weight; linear effect of dietary lactose level (P<..01).

Another point of interest is the source of carbohydrates in weaner pig diets. The results summarized in Table 3 demonstrate that at least 15% lactose is required in the diet for piglets weaned at 21 days of age and at 5.4 kg body weight. The inclusion of lactose may have various affects on digestion in the piglet, including reducing the passage rate of food through the digestive tract and the development of bacteria (lactobacilli) that influence the fermentation of dietary carbohydrates in the gut and that have positive effects on gut health.

As lactose is now available in a purified form, products like dried whey and skim milk are no longer required as a source of lactose per see. This has increased the amount of research into other reasons for the positive effects of dried whey and/or skim milk on piglet performance. It has also stimulated the interest in evaluating the value of other carbohydrates, such as oligosaccharides and fermentable carbohydrates, and even probiotics in weaner pig diets. It is for example now clear that short chain fatty acids that are derived from fermentable carbohydrates are an important source of energy for the gut in monogastric animals (McBurney, 1992). Sources of fermentable carbohydrates include barley, beet-pulp and even peat moss. This may explain some of the positive effects of including some of these ingredients in piglet diets. For example, in a recent trial conducted at the University of Guelph we observed substantial improvements in growth rates during the first two weeks after weaning when piglets were given unlimited access to peat moss (Table 4). In addition, the number of poor-doing piglets that had to be removed from the experiment was reduced in piglets fed peat moss.

Table 4. Effect of unlimited access to peat moss on piglet performance during the first two weeks after weaning

	Access to peat moss	
	NO	YES
No. of piglets	92	91
Weaning weight	6.34	6.33
Gain, g/d	196	229 (+16%)
Feed intake**, g/d	283	285 (+1%)
Feed : gain**	1.42	1.26 (-12%)
Peat moss usage, g/d	–	341
No. of poor-doing piglets removed from the trial	8	1

*Feng et al., unpublished; piglets were weaned at about 25 days of age; piglets were give access to peat moss from 7 days of age until 2 weeks post weaning; differences in growth rates and no. of piglets removed from the trial were significant (P<.05). **excludes the consumption of peat moss

Another recent finding is that a particular amino acid, glutamine, appears to be important for the development of the gut. This amino acid can serve as an important energy source to the gut and is required for the proliferation of cells in the gut wall. i.e. for the growth of gut tissue. It is thus not really a surprise that glutamine is the most abundant amino acid in sows' milk (Wu and Knabe, 1994).

Table 5. Effect of dietary glutamine supplementation on growth performance of newly weaned pigs fed corn- and soybean meal-based diets*

	Dietary glutamine supplementation			
	0%	.2%	.6%	1.0%
Performance day 1 to 7:				
Gain, g/d	0.7	.03	.05	.03
Feed intake, g/d	.19	.14	.15	.13
Feed : Gain	2.8	4.8	2.94	4.35
Performance day 7 to 14:				
Gain, g/d	.23	.24	.28	.27
Feed intake, g/d	.35	.34	.36	.32
Feed : Gain	1.49^{b}	1.37^{ab}	1.32^{ab}	1.19^{a}

*Wu et al., 1996; piglets were weaned at 21 days of age; 10 piglets per treatment.
a,b values within rows and followed by different superscripts are significantly different.

The results summarized in Table 5 demonstrate that the inclusion of up to 1% glutamine in a corn-soybean based diet significantly improved feed conversion efficiency in the 2nd week after weaning. In this study, ingredients that are known to improve performance in newly weaned piglets (e.g. whey, blood plasma, skim milk, etc.) were not included in the experimental diets. This explains the poor performance that was observed in the first week after weaning. But it also indicates that the benefits of including glutamine (or other amino acids that are related to glutamine metabolism) remains to be determined in more typical weaner pig diets.

Protective factors in sows' milk.

It has been long recognized that the sows' milk provides protection against disease causing organism in young piglets. This can largely be attributed to the immunoglobulins (anti-bodies) in the sows' milk. These immunoglobulins can be isolated from milk as well as from blood plasma. The results summarized in Table 6 illustrate that the inclusion of purified immunoglobulins from either pigs' or cows' blood can improve survival rate, reduce the incidence of diarrhea and improve the 21 day weight in piglets.

Table 6. The effect of including immunoglobulins in pig milk replacers on piglet performance between birth and 21 days of age*

	Immunoglobulins		
	None	from cows	from pigs
Survival rate, %	18	67	92
Diarrhea score**	3.1	1.1	1.1
Body weight on day 21, kg	2.06	4.20	4.67

*Drew et al., 1990.
* * score 1 to 4; 1 =normal to 4=watery manure, all fluid.

It is very likely that the positive effects of including blood plasma products in weaner pig diets are attributed to the presence of immunoglobulins in these products. Plasma products can thus effectively replace milk products in weaner pig diets; in particular in a "dirty" environment (Table 7). The results in Table 7 also illustrate the very large effects of health status (e.g. experimental vs conventional, commercial nursery) on feed intake and gain in young piglets.

Table 7. Interactive effect of environment and dry skim milk (DSM) vs spray dried blood plasma (SDPP) in the weaner diet on performance in newly weaned piglets*.

	Experimental nursery		Conventional nursery	
Protein Source	DSM	SDPP	DSM	SDPP
Gain, g/d	304	323	192	238
Feed intake, g/d	419	496	269	352
Feed : Gain	1.39	1.54	1.43	1.48

*performance during the first 2 weeks after weaning 5.4 kg body weight; Coffey and Cromwell, 1995.

Regulatory factors in sows' milk.

In recent years we have become more aware of some regulatory factors (hormones) present in sows milk, and in particular an hormone called epidermal growth factor (EGF). EGF is important for the development of the gut and the digestive capacity in young mammals (Table 8).

Table 8. Effect of epidermal growth factor on the ability to absorb glucose in the small intestine of young mice

	Control	+EGF
Weight of small intestine, g	1.79	1.93 (+8%)
Glucose uptake pmol/min/mg of tissue:		
Active	177	225 (+27%)
Passive	93	117 (+26%)
Total	270	342 (+27%)

*Bird et al., 1994; when starch is digested glucose is produced; the absorption of glucose is essential to the utilization of cereal grains.

Over the next few years we will see more research on the specific effects of EGF and other regulatory factors present in sows' milk on the development of the digestive capacity and feed intake in the young newly weaned piglet. In addition, alternative inexpensive sources of these factors will be sought; purified EGF is still far too expensive for routine inclusion in piglet diets.

Enzymes.

Enzymes are essential for the breakdown of nutrients in the piglets' guts before these nutrients can be absorbed and utilized by the piglet. Various studies suggest that the amounts of enzymes secreted into the gut by piglets themselves may not be sufficient for optimal digestion of dietary nutrients. This is likely why some digestive enzymes are included in the sows' milk. In many experiments the effects of adding (exogenous) enzymes to the piglets' diets on piglet performance has been evaluated. Unfortunately, the results of these experiments have not always been consistent. However, we anticipate that exogenous enzymes will play an important role in weaner pig nutrition in the future, once the main concerns of using exogenous enzymes have been addressed (enzyme stability, specificity and quality control).

SOME ALTERNATIVE MEANS TO STIMULATE FEED INTAKE IN NEWLY WEANED PIGLETS

In terms of feeding management there are several factors that are known to affect feed intake and performance in newly weaned piglets. Again a few of these are discussed below.

Feedform

There is little solid research on the effect of feed from on feed intake and feed

utilization in young piglets. Pelleted or crumbled diets will minimize wastage. However, the undeveloped teeth of young piglets will make it difficult for piglets to chew and break hard large pellets. Therefore, small pellets (2 mm in diameter) or crumbles are recommended. Meal diets can be used but feed wastage may be 20% higher than that on pelleted or crumbled feeds (Swine Nutrition Guide, 1995; Nelssen et al., 1995).

One of the most successful means to enhance feed intake shortly after weaning is wet or gruel feeding. Observations made on commercial farms in Britain indicate that gruel feeding may increase feed intake in the first week after weaning by as much as 35% (SCA nutrition; Toplis, 1995). This is further supported by the observation that wet feeding stimulates the development of the gut in newly weaned piglets (Pluske et al, 1995). The improvements in feed intake with gruel feeding may be related to piglet behaviour as well: piglets do not have to learn both a drinking and a feeding behaviour as feed and water are available from the same source. When gruel feeding a water to feed ratio of about 2.5 to 1 should be targeted. However, if wet or gruel feeding is applied, great care should taken to ensure that the feeders remain clean and that the feed remains fresh, i.e. that no moulds or bacteria develop in the wet feed.

Phase feeding versus choice feeding

During the first few weeks after weaning both the digestive capacity and nutrient requirements of piglets change rapidly. Phase feeding schemes accommodate these changes. In early weaning programs, it is now not uncommon to feed more than three different diets between the time of weaning and approximately 25 kg body weight. In these phase feeding programs, important decisions have to be made as to when diets should be changed. Factors to consider include, the age and weight of the piglets, previous feed consumption, environmental conditions and health. Moreover, there will always be differences between batches of piglets and even variation within batches of piglets that should be considered. If diets are changed too quickly, digestive upsets are likely to occur and piglet performance will be sacrificed. If, on the other hand, diets are changed too slowly, feed costs will increase rapidly. Some real discipline is required to make these phase feeding programs work properly. A good starting point will be the development of feed budgets: develop targets for the actual amount of each of the diets piglets should consume, and monitor performance and feed cost in representative groups of pigs (Nelssen et al., 1995). The group of nutritionists at Kansas state suggests that piglets should receive 1.8, 7 and 23 kg of typical phase 1, Phase 11 and Phase III diets, respectively, between weaning at 3 weeks of age and about 23 kg body weight.

A means to avoid making decisions about when feeds should be changed is to have the piglets themselves decide what they need or prefer. This is the basis of choice feeding: pigs are give simultaneous access to two diets that differ in nutrient levels and complexity (i.e. content of expensive ingredients). In one of our studies at the University of Guelph, piglets on a choice feeding program grew about 8% faster and ate slightly more feed as compared to piglets on a typical 3-phase feeding program (Table 9). However, this slight improvement in performance did not offset the increased feeding cost for the piglets on the choice feeding program; the piglets in the choice feeding program consumed too much of the more complex phase I diet. Based on this we would certainly not recommend to implement choice feeding for young piglets. However, it did show us that the performance on the phase feeding program was below the piglets potential and likely limited by nutrition. In a subsequent study (data not shown) we made some modifications to the phase feeding program as well as the choice feeding program (piglets had access to the phase I and 11 diet during the first 2 weeks after weaning and to the phase 11 and phase III diet for 2 weeks thereafter); in that study we no longer observed any differences in performance between phase and choice fed piglets.

Table 9. Choice versus phase feeding pigs weaned at three weeks of age*

	Feeding method	
	Phase	Choice
Body Weight		
initial	5.6	5.66
final	27.2	28.8
Gain, g/d	516	551
Feed intake, g/d	720	748
Feed : gain	1.39	1.35

Feng et al., 1995; Piglets on the phase feeding program were fed commercial phase 1, 11 and III diets for 10, 14 and 21 days respectively; in the phase feeding program piglets received 3.1, 7.2 and 17.2 of the phase 1, 11 and III diets respectively; the choice fed pigs had continuous and simultaneous access to the Phase I and the Phase III diet; in the choice fed piglets more than 50% of feed usage was the phase I diet.

Strategic use of feed flavours

Flavours are routinely added to commercial pig starter diets in Canada. Yet, the value of various flavours in high quality pig starter diets remains questionable. McLaughlin (1983) showed that a specific cheesy flavour increased feed intake in newly weaned piglets by as much as 24%. This effect was observed during the first week after weaning only; in subsequent weeks no effects of feed flavour on feed intakes were observed. In that same study, other flavours did not appear to have any affects on feed palatability or feed intake. Another interesting finding was made by Campbell (I 976). He showed that piglets tended to eat more of a creep feed that was flavoured with the same flavour as the sows' diet. Apparently the flavour from the sows' diet was transferred into the milk, and piglets associated the flavour in the creep feed with their positive experiences associated with consuming sows' milk. It appears that the targeted use of well tested feed flavours can be used to stimulate feed intake in newly weaned piglets. At the University of Guelph we are currently conducting some preliminary studies to determine whether piglets associate feed flavour with the quality of particular weaner diets and whether a change in feed flavour will stimulate feed intake if piglets have had negative experiences with flavoured diets that were fed previously.

CONCLUSIONS

Growth rates of young piglets managed under commercial conditions are substantially below their performance potentials. Improvements in growth rates and feed efficiencies can be achieved through stimulation of feed intake and of the digestive capacity in these piglets. A better understanding of the growth stimulating factors that are present in sows' milk will allow us to develop diets in which alternative feedstuffs and feed additives can replace expensive milk products and/or blood plasma products. Factors that can be considered to enhance feed intake and the digestive capacity in young piglets include fermentable carbohydrate sources (lactose, beet pulp, peat moss), blood plasma products, glutamine, well developed phase feeding programs, gruel feeding, and the strategic use of effective flavours.

SELECTED REFERENCES

Bird, A.R., W.J. Croom, Y.K. fan, L.R. Daniel, B.L. Black, B.W. McBride, E.J. Eisen, L.S. Bull
and I.L. Taylor. 1994. Jejunal glucose absorption is enhanced by epidermal growth factor. J. Nutr. 124:23 1.

Campbell, R.G. 1976. A note on the use of feed flavour to stimulate feed intake of weaner pigs. Anim. Prod. 23:417.

Coffey, R.D. and L.Cromwell. 1996. The impact of the environment and antimicrobial agents on the growth response of early weaned pigs to spray-dried porcine plasma. J. Anim. Sci. 73:2532.

Drew. M.D. and B.D. Owen. 1988. The provision of passive immunity to colostnun deprived piglets by bovine or porcine serum immunoglobulins. Can. J. Anim. Sci. 68: 1277.

Hodge, R. W. 1974. Efficiency of food conversion and body composition of the preruminant lamb and the young pig. Brit. J, Nutr. 32:113.

Feng, C., C.F.M. de Lange and A. Pharazyn. 1995. Choice vs Phase feeding of newly weaned pigs. 1995 Ontario Swine Research Report. Dep of Animal and Poultry Science, University of Guelph.

Flemming, S.E., M.D. Fitsch, S. DeVries, M.L. Liu and C. Knight. 1991. Nutrient utilization by cells isolated from ratjejeunum, cecum and colon. J. Nutr. 121: 869.

McBurney. M.I. 1992. The role of locally available nutrients in gastrointestinal function of monogastrics. Proc. I')th -Western Nutrition Conference, University of Saskatchewan, Saskatoon, SK. pl4l.

McLauglin, C.L., C.A. Baile, L.L. Buckholtz and S.K. Freeman. 1983. Preferred flavours and performance of weanling pigs. J. Anim. Sci. 56: 1287.

Nelssen, J.L., R.D. Goodband, S.S. Dritz and M.D. Tokach. 1995. The effect of weaning age on nursery pig feeding behaviour and growth performance. In (G. Foxcroft Ed.): Advances in Pork Production; Proceedings 1995 Banff Pork Seminar. Department of Food, Nutritional and Agricultural Sciences. University of Alberta, Edmonton.

Pettigrew. J.E., L.J. Johnston, G.C. Shurson and J.D. Hawton. 1994. Feeding nursery pigs. In:Proc., Pre-conference Nutrition Seminar. American Association of Swine Practitioners. University of Minnesota, St. Paul.

Owen, K.Q., J.L. Nelssen, R.D. Goodband, M.D. Tokach, S.S. Dritz and L.J. Kats. 1993. The effect of increasing levels of lactose in a porcine plasma based diet for the early weaned pig. J. A,nim. Sci. 71 (Suppi. 1): 175.

Pluske, J.R., I.H. Williams and F.X. Aherne. 1995. Nutrition of the neonatal pig. In. (Varley, M.A. Ed.) The neonatal pig; development and survival. CAB International. Wallingford. Oxon, OXIO 8DE, U.K. pp. 187.

Tokach, M.D., R.D. Goodband, J.L. Nelssen and D.R. Keesaker. 1992. Influence of weaning weight and growth during the first week postweaning on subsequent pig performance. In:Proc. of the American Association of Swine Practitioners. University of Minnesota, St.Paul.

Toplis, P. and S. Tibble. 1995. Appetite management of the pig - beyond diet formulation. Proc.1995 Saskatchewan Pork Symposium.

van der Kerk. 1988. In (G. van der Peet; author): Nutrition of piglets after weaning (in Dutch). Research Institute for pig Husbandry, Rosmalen, The Netherlands.

Widdowson, E.M. and D.E. Crabb. 1976. Changes in the organs of pigs in response to feeding for the first 24 h after birth. Biol. Neonate, 28: 261.

Wu, G. and D.A. Knabe. 1994. Free and protein-bound amino acids in sow's colostr-um and milk. J. Nutr. 124: 415.

Wu. G., S. Meier and D.A. Knabe. 1996. Dietary glutamine supplementation prevents jejunal atrophy in weaned pigs. J. Nutr. 126: 2578.

| Top of Page |

| Livestock Home Page |

| Central Site | Feedback | Search | Site Map | Français |
| Home | What's New | Calendar | Products | News Releases |

Ontario
This site maintained by the Government of Ontario, Canada

This information is provided as a public service, but we cannot guarantee that the information is current or accurate.
Readers should verify the information before acting on it.

Feedback and technical inquiries to: livestock@omafra.gov.on.ca
© Copyright 2001 Queen's Printer for Ontario
Last Updated: January 29, 2001